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Labor Supply, Labor Demand and Occupational Mobility

Gegenstand des Beitrags ist ein konzeptioneller Rahmen zur quantitativen Modellierung dynamischer Arbeitsmarktprozesse auf der Mikroebene einzelner Personen. Den Ausgangspunkt bildet die Beschreibung beruflicher Mobilität als Match-Prozeß zwischen individuellen Arbeitsanbietern und beruflichen Positionen, die von Arbeitsnachfragern bereitgestellt werden. In einem zeitkontinuierlichen Hazard-Raten Modell kann dann die individuelle Übergangsrate zerlegt werden in eine spezifische Nachfragekomponente, eine Informationskomponente sowie die Wahrscheinlichkeiten für die Annahme des jeweiligen »Matchs« durch den Arbeitgeber beziehungsweise den Arbeitnehmer. Der Ansatz berücksichtigt damit für die Erklärung der beobachtbaren Mobilitätsprozesse sowohl die Angebots- wie auch die Nachfrageseite des Arbeitsmarktes und deren Interaktion. Zur Schätzung derartiger Modelle sind Longitudinaldaten erforderlich, wie sie nunmehr auch für Deutschland bereitgestellt werden.

1. Introduction

In the following, an attempt is made to develop a conceptual framework for a model of dynamic labor market processes that incorporates both the supply and demand side of the labor market. This is based on the idea that for employed work, occupational opportunities depend on the jobs available to workers and on the hiring practices of the prospective employers. At the same time, hiring decisions of employers will depend on the supply ofworkers willing to accept the jobs offered. Only if the behavior of both employers and workers and their interactions on the labor market are considered explicitly, will one be able to explain fully the structure of the processes being observed.

The labor market is basically described as a matching process between individuals and positions, be it in or out of the labor force. In such a context, labor market processes are modelled as transitions between occupational positions with labor supply as a special form of occupational mobility between positions out of the labor force and positions in the labor force. Thus, the approach builds on earlier work on microeconomic flow models of the labor market (e.g. Toikka 1976, Burdett and Mortensen 1978, Flinn and Heckman 1982b).

Besides employed work in different types of jobs, positions in the labor force include self employment, work as a helping family member and unemployment. Positions out of the labor force may be classified for instance into schooling, retirement, house work, and so on as different states, since these imply different activity patterns and different outcomes for the individual. All positions, be they in or out of the labor force, are grouped into positional categories which are assumed to be of some homogeneity with regard to qualifications and efforts required and rewards provided. However, within each category some random differences between distinct positions are assumed.

As a formal framework, the hazard rate approach of transition models is used which has been applied in occupational mobility research for some time (e.g. Tuma 1976, Tuma and Robins 1980, Sorensen and Tuma 1981) and is now being adopted by economists (e.g. Flinn and Heckman 1982a, Heckman and Borjas 1981). Formally, the position occupied defines the state of the individual. The modelling task then consists in the explanation of the transition rates between different states. An attempt is made to decompose these rates into structural components. This is done in a continuous time context, since it is more convenient for both theoretical and formal arguments.

In the core of transition models is the modelling of transitions as a stochastic process, which is described by the probability distribution of first passage time. This is the time T after which the first change in the state takes place. For a simple two state problem, like labor force participation of nonworking persons, this might be the transition from out-of-the-labor-force to in-the-labor-force. Let F(t) be the cumulative probability distribution for changes taking place in the time interval $0 < T \leq t$ and f(t) the corresponding probability density function. The hazard rate, h(t), then is defined as the instantaneous probability of a change occurring after time t, given that no change has occurred before t.

(1) $$h(t) = f(t) / (1 - F(t)) \geq 0$$

According to (1), a given F implies a given h, and conversely, a given h implies a uniquely defined F. From (1), one gets the following expressions for F(t) and f(t).

(2) $$F(t) = 1 - \exp\left(-\int_0^t h(u)du\right)$$

and

$$f(t) = h(t) \cdot \exp\left(-\int_0^t h(u)du\right)$$

An extension to problems with more than two different states and consequently more than one possible transition is rather simple. For a given state, transitions to other states constitute competing risks, which may be modelled as independent stochastic processes (Tsiatis 1975), each with a specific hazard rate. For each of these processes, expressions (1) and (2) hold correspondingly. The probability to move to a specific state can then be derived by simple probability calculus.

Since the hazard rate is a measure of the instantaneous probability oftransitions, it describes the individual's propensity to change at a given moment in time. Therefore, modelling hazard rates is a direct way to model the dynamics of change underlying a transition process. Conditional on the state occupied, for every moment of time the propensity to move to another state can be explained by making the hazard rate dependent on the relevant explanatory variables.

There are also advantages of rate models on the formal level. The only formal constraint on hazard rates is non-negativity while transition probabilities, f(t), are additionally subject to the condition that the cumulative probability to move may not exceed unity. Therefore rate models are more easily specified, since fewer constraints have to be taken into account.

2. A Framework for a Demand-Supply Model of Labor Market Processes

On the labor market, an individual can only be matched to an available position. Thus, transitions are constrained by the number of open positions. Additionally, positions differ in their availability to individuals. Probably, few errors are made if it is assumed, that, in principle, self employment and house work are options available to all individuals at any time. Access to schooling and retirement is restricted by institutional regulations that define criteria of eligibility. But, given eligibility, practically all individuals have the option to choose schooling or retirement. Unemployment may be regarded as a special position without restricted access that either may be chosen voluntarily or is entered involuntarily by individuals who have been dismissed and have not found a new job before leaving their former job. Access to employed work is controlled by employers providing jobs and deciding on whom to hire on the job.

Thus, availability of positions can be decomposed into three factors: the number of vacant positions, information on vacancies, and the hiring decisions of employers. Beside these demand-side factors, observed mobility behavior additionally depends on labor suppliers' decisions to accept positions becoming available to them.

Occupational opportunities consist of the positions permanently open to an individual and vacant jobs that become available. Let v(j,t) be the number of vacant jobs of type j at time t. Additionally, each position will be assigned a vector x of attributes that are relevant for occupational choice. This might be the wage rate, qualification requirements, working time, other work conditions, and so on. Within the same category, positions will show some variation in these attributes.

Information on a vacancy is acquired through information channels like labor market institutions or informal social networks. Imperfections of these channels can be modelled by assuming that an individual gets information on a given vacancy by a random process. The rate of information arriving at the individual depends on factors like the institutional and geographical setting as well as the search strategy adopted by the individual. For simplicity, the rate of information is written as a rate m(jlz) depending on the type j of the vacancy, conditional on a vector z of characteristics of the individual.

An employer's decision to hire a person for a vacant job can be modelled as a random event, if it is assumed that employers differ in their hiring practices and individuals contact vacancies at random. The probability, q(j, ilz), that an individual presently in position i will be regarded by the employer to be acceptable on a randomly selected vacancy of type j is defined conditional on the individual's characteristics z. Both the present position and the individual's characteristics probably will be used to assess the individual's qualification for the job in the course of some screening procedure.

In the same way, the individual's decision to accept a job offer of type j when in an position of type i maybe described by a probability, p(j, ily, z), conditional on the attributes of the present position y as well as the individual's characteristics z. A justification for such a specification can be derived, for instance, from random utility theory. If it is assumed that mobility decisions are based on utility judgements and that random factors enter into these judgements, the outcome of a decision will be a random event. Random elements may enter the decision either because there are differences between jobs or individuals not measured by the respective attributes, or the internal decision process just may contain some random elements.

Putting pieces together, the hazard rate, h(j, ily, z, t), for an individual with characteristics z to move from a position i with characteristics y to a new position j can be expressed approximately as the product of the overall number, va, t), of vacancies of that type at time t, the rate, m(jlz), of information on jobs of that type arriving at the individual, the probability, q(j, ilz), that the individual will be acceptable to the employer, and the probability, p(j, ily, z), that the individual will accept the job. The product form will be approximately valid, if it is assumed that at most one vacancy will be found in an infinitesimal period of time and that the information process and the decisions of workers and employers respectively are stochastically independent, given the explanatory variables. This assumption is not very restrictive if there are many workers and many employers in the labor market.

(3) h(j, ily, z, t) = v(j,t) • m(jlz) • q(i, jlz) • p(i, jly, z)

According to this decomposition, the transition rate into a job will change positively with the number of vacant jobs of that type. Improved information on vacancies will increase the transition rate, as well as increases in the propensities to hire persons or to accept jobs as measured by the respective probabilities.

For positions permanently available to the individual, a different interpretation has to be given to the components of the hazard rate. If there are no restrictions on moving into a position, the transition rate will depend only on the individual's propensity to choose that position. For the sake of notational simplicity it is assumed that in this case m(.) denotes the rate at which such decisions are made and p(.) is interpreted as the conditional choice probability as for other positions. If access is restricted, eligibility can be described by a dummy variable taking the value one in the case of eligibility and zero otherwise. Again, to simplify matters, the notation q(.) is used, since this dummy variable may be interpreted as the probability of being eligible for the position. Additionally, for these positions, the term v(.) is defined to equal unity. Similarly, for unvoluntary transitions into unemployment, the probability of acceptance p(.) by definition equals unity. In this case, m(.) may be interpreted as a measure of general unemployment risks and q(.) as the probability, that the employer will dismiss the specific individual.

Using (3), the probability of a transition occurring after time t can be determined from the multivariate generalization of relation (2).

(4) r(j, ily, z, t) = h(j, ily, z, t) • exp. ($_{;i}$J`E_K h(k, ily, z, u)du)

The corresponding probability that no transition occurs before time t is given by:

(5) G(y, z, t) = exp. ($_{â}$J`E_K h(k, ily, z, u)du)

Transition probabilities between two positions not only depend on the number of vacancies in the destination, but also on the number of vacancies for all other positions. Other things remaining equal, an increase in the number of vacancies for one position will reduce the transition probabilities to other positions, given there is a positive probability workers will accept the position. Some fraction of individuals who would have moved into other positions will instead be allocated to the position with higher demand. The same is true if the probability to be accepted by an employer is increased for one position. Changed hiring practices of employers will lead to changing mobility patterns. The same is true if workers change their propensities to accept jobs.

According to (3), the rate of mobility does not depend on the number of individuals competing for jobs. This may appear counterintuitive, since one could expect competition between workers to affect individual chances to move into a new position. However this is not true for an infinitesimal period of time, as can be shown by simple probability calculus.

If applications by different individuals are assumed to be independent, they constitute competing risks that have a formal description analogue to (3) through (5) with the sum over positions replaced by the sum over individuals. The probability for an individual's application for a vacancy to be the first one after time t is defined analogously to (4). The probability that no application at all will have occurred before time t corresponds to expression (5). Since the individual hazard rate of applying first for the vacancy and getting the position is defined according to (1) as the quotient of these two probabilities, the terms containing the rates for other individuals cancel and the simple rate, according to (3), remains.

There is no direct dependency of the instantaneous individual mobility rate on the number of individuals competing for vacancies. It depends only upon the number of vacancies available. However, an indirect link exists, since this number will change in response to changes in labor supply.

The rate at which vacancies are filled is defined as the sum of the individual propensities to move into the position. Other factors remaining equal, a higher labor supply, therefore, implies that vacancies are filled faster and the number of vacancies available on the market is reduced. This, in turn, reduces the mobility opportunities. Thus, even if the individual propensities to move, as measured by the transition rates, remain unchanged, mobility rates drop, when supply of labor is rising compared to labor demand, simply because vacancies are filled faster and other opportunities are lacking.

3. Structural Aspects of the Model

Of the three behavioral components of the mobility rate in addition to the number of vacancies, least seems to be known about the working of information channels in the labor market. In search theory, the rate at which offers arrive usually is treated as a given constant. Only a few authors have tried to endogenize search efforts and the corresponding rate of successful search (e.g. Burdett 1979). In labor economics some attention has been paid to the information channels used by unemployed persons to learn about job offers. But there seem to be no well developed formal models that explain individual access to information about vacant jobs. Therefore, the best one may presently do is to introduce some ad hoc hypotheses on information channels. In the simplest case, specific constants can be assumed for respective rates depending on the occupational categories concerned.

More developed theories are available for the decisions of both workers and employers to accept or to reject an occupational arrangement and the decision on the dismissal of workers. Starting from standard microeconomic theory, one would expect that these decisions, in principle, are based on a comparison of the net future benefits expected from a specific choice. Net benefits here are defined in a broad sense to represent monetary and non-monetary benefits and costs, including expected future benefits of eventually moving to other states. The decision to dismiss a worker can also be modelled in such a framework, since it too will be based on a comparison of the net benefits to be expected from either keeping the worker on the job with the chance of future dismissal, his quitting, or dismissing him right away and searching for another worker.

For a more formal exposition, let b(j, x, z, t) denote the net benefits expected by a decision maker with characteristics z from an alternative of type j with attributes x at time t. The value b(i, y, z, t) for the presently occupied state i with attributes y defines the reservation level of expected benefits for accepting alternatives, since another state will be accepted only if its expected benefits exceed those of the original state. As alternatives becoming available differ randomly, a probability distribution G(j, x, t) over the attribute space of alternatives of type j is assumed. If offers are independent from the present state, the conditional probability that a given decision maker with reservation level b(i, y, z, t) for expected benefits will accept a randomly selected alternative of type j in general can be written as:

$$(6) \qquad a(j|i, y, z, t) = \text{Prob}\,(b\,(j, x, z, t) > b(i, y, z, t)) \\ \int_{b(j, x, z, t) > b(i, y, z, t)} dG(i. x, t)$$

In principle, a recurrence relation can be obtained for the reservation level of benefits b(.) from search theory. Expected benefits from a given state can be expressed as the sum of the present value of expected benefits from remaining in that state and the expected gains from moving to other states weighted by the respective instantaneous probabilities. However, restrictive assumptions have to be introduced to derive workable expressions. Stationarity of the transition process and an infinite time horizon are assumed for instance by Flinn and Heckman (1982b). In this case, expected benefits for all states, in principle, can be derived as the solution of a simultaneous equation system, given a parametric representation of the offer distributions G(.).

However, even if a specific parametric form like the normal is assumed for the offer distributions, the derivation of the reservation levels and the corresponding choice probabilities remains rather involved. At the same time, it could be asked whether the rational choice model provides a valid description of actual expectation formation by individuals, since unrealistic assumptions like stationarity are used in its derivation. Given the complexity of the decision problem, actual decisions might be based on other simplifications which might result in different behavioral relations. For example, individual expectations might be based on information becoming available from contemporal cross sectional observations. However, whether this is true or other relations hold is an empirical question that cannot be answered on the basis of theory alone, but empirical information on mobility decisions is needed.

An alternative modelling strategy could consist of an attempt to formulate a general framework for individual decisions first and then decide on the specific form of the relation on the basis of empirical information. As a general framework for modelling of individual decisions, the quantal choice concept developed in random utility theory can be adopted (cf. Maddala 1983). If benefits b(i, x, z, t) in (6) are decomposed into the sum of their expected value b* (i, x, z, t) and a random deviation e(i, t) from that, the acceptance decision can be described as a binary qualitative choice problem. The probability that a randomly chosen alternative of type j will be preferred to state i can be expressed as a function of the expected values for each alternative and the probability distribution 1 [e(j, t) - e(i, t)] of the difference of the random elements.

$$
\begin{aligned}
(7)\quad & a(j\sim i, y, z, t) \\
&= \mathrm{Prob}\,(b^*(j, x, z, t) + e(j, t) > b^*(i, y, z, t) + e(i, t)) \\
&= \mathrm{Prob}\,(e(j, t) - e(i, t) > -(b^*(i, y, z, t) - b^*(j, x, z, t))) \\
& \qquad [e(j, t) - e(i, t)] \\
& - (b^*(j, x, z, t) - b^*(i, y, z, t))\ f
\end{aligned}
$$

If, additionally, a standard normal or logistic form is assumed for cp [.], the usual binary probit or logit formulation is obtained, with the decision probability depending only on the difference between the expected values. In this case, the specification problem is reduced to the specification of relations for the expected value of benefits attributed to each of the alternative states. This, however, again implies the need to specify relations for the future benefits expected from different choices.

Independent of the specification used, the explanatory variables represent the effects of observed heterogeneity of decision makers and alternatives on decisions. But beside that, unobserved differences exist, that are modelled by the random component of evaluations. Since independent random matches are assumed between workers and positions, unobserved heterogeneity of employers and positions will result in independently distributed random effects. However, unobserved differences both between individuals and between positions currently held will affect the sequence of individual decisions. This will lead to serial correlation of the corresponding latent factors. Therefore, an error component structure should be used for the latent part of the evaluation with one component being specific to the individual, another specific to the current state, and a third unspecific component which catches all other random effects. In principle, this leads to a model similar to the general dynamic choice model that has been introduced by Heckman (1981) into quantal choice theory.

The decision probabilities of both employers and workers depend on the corresponding probability distribution of offers available. Usually these distributions are treated as exogenously given. But in principle, a feedback exists between the offer distributions of vacancies and applications on the labor market. The distribution of job offers available to workers depends on hiring strategies of employers, and the distribution of hiring opportunities for employers depends on search strategies of labor suppliers. Since at the same time acceptance decisions depend on the offer distributions, these distributions in a strict sense should not be treated as exogenous but should be explained endogenously. Such a model has been conceptualized, for instance, by Pissarides (1976) or Mortensen (1976), but an operational formulation is still missing due to the complexities of the problem.

However, for modelling purposes, the feedback between supply and demand side decisions may be neglected, if it is not anticipated by individuals in their decisions. In this case, for the individual decision the offer distribution is treated as given. Additionally, if there are many individual decision makers in the market, by the law of large numbers, the total offer distributions will practically not be affected by random variations in individual behavior as long as individuals behave independently. Parameter estimates, therefore, will be subject to almost no simultaneous equation bias, if offer distributions are treated as exogenous and feedback between individual decisions and offer distributions is neglected for estimation.

4. Data Requirements

The discussion of the data needs of the modelling approach can start from the decomposition of individual mobility rates into the factors of labor demand, availability of information on vacancies, and the acceptability of matches to employers and workers respectively. Besides occupational mobility as the dependent variable, longitudinal information on these four areas is required to analyze the dynamic change in the setting of individual mobility behavior in full detail. At least in part, such data can be obtained from household panel studies like the Panel Study of Income Dynamics or the National Longitudinal Surveys in the US, or the new German Socioeconomic Panel Study.

Measurement of labor demand is closely tied up with the definition of occupational mobility, since the demand variable should represent a measure of the occupational opportunities faced by the individual. Consequently, the same occupational classification should be used for both mobility and demand measures. However, since total labor demand cannot be derived from household data, information has to be obtained from other sources like employment statistics. This implies severe constraints for the definition of occupational categories, since, at least for Germany, demand data are only available on the basis of the official occupational classification system.

Besides data on occupation, more information is necessary to properly describe the relevant segments of labor demand. Geographical factors will be especially important for at least some occupations in as much as job search is restricted to a region. Therefore, panel data on individuals should provide geographical information that allows one to link individual mobility to the dynamics of regional labor markets. However, this may lead to conflicts with data privacy policy, if small geographical entities, such as counties, are considered.

Availability of information on opportunities seems to be a problem not yet really tackled by data producers. Usually, only actual changes in occupation are recorded, but no information is gathered on the alternatives available to individual choice. On the other hand theory tells us that the composition of the choice set as perceived by the decision maker is of crucial importance for individual choice behavior. Since actually observed transitions are a result of both opportunities and individual choice, it is difficult to identify the isolated effects of both factors from data on observed transitions. This becomes most evident for individuals who do not move in the sample period. The reason may be either lack of opportunities or a preference to remain in the position held. With data on actual moves only, one cannot discriminate between these two explanations. Improved behavioral hypotheses could be developed, if data on information available to individuals could be obtained.

Similar problems exist with respect to the analysis of the acceptability of matches to employers and workers and the corresponding decisions. Only data on accepted jobs are provided, and little is known about matches turned down either by employers or workers. Again, more information on the unsuccessful matches would provide a better understanding of the decision processes underlying occupational change. Some information might be obtained from household interviews, if data on unsuccessful applications for jobs and reservation criteria for individual job search were collected. At least the number of applications when searching for a job could be obtained, and possibly even some information on the type of job that could not be obtained. Similarly it should be possible to get information on the criteria labor suppliers use when deciding whether to accept a job or not.

Even more could be inferred about the determinants of occupational mobility, if parallel data were available on the decisions of employers and labor suppliers with regard to accepting or turning down potential work contracts. In the same way that workers could be asked for their minimum requirements concerning job acceptability, information could be collected on the hiring decisions of employers. In its ideal form, such a data base would provide longitudinal information on both employers and labor suppliers. On this basis, a full structural model of labor market processes could be developed on the micro-level of individual decision makers. At the same time, such data would provide better insights into the factors governing allocation in the labor market and thus allow improved labor market policies.

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